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# Fuzzy Inference System (FIS) Rule Based Heart Disease Prediction System To Predict Risk Level Of Heart Disease

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***Abstract*— An intelligent, accurate and efficient diagnostic system is necessary for better diagnosis and treatment of heart disease patients. Heart disease diagnosis is a challenging task which can offer automated prediction about the heart disease of patient so that further treatment can be made easy. Efficient knowledge based expert systems played an important role to reduce the risk of heart disease. Fuzzy rule based expert system played an important role in diagnosis of heart disease with improved effectiveness. With the growing research on heart disease predicting system, it has become important to categories the research outcomes and provides readers with an overview of the existing heart disease prediction techniques. This paper study and review the fuzzy expert system to diagnose the heart attack risk for different patients based on a set of symptoms and rules.**

***Keywords*— Heart disease, Fuzzy inference system, Disease diagnosis, Machine learning, Neural network.**

## I. INTRODUCTION

Today peoples around the world are very much conscious over their health and wellness. The cardiovascular disease enhancing really quick and it has actually become the leading cause of death worldwide [1, 2]. Health domain application is one of one of the most active study area nowadays. Intelligent computer and machine learning techniques make it possible to develop software that assists doctors in making decision of heart disease in the early stage. The diagnosis of heart disease depends on clinical and pathological data. Heart disease prediction system can assist medical professionals in predicting heart disease status based on the clinical data of patients. Clinicians and patients need reliable information about an individual's risk of developing Heart Disease. Ideally, they would have entirely accurate data and would be able to use a perfect model to estimate risk. Indeed, the perfect model would even be able to predict the timing of the disease's onset.

The risk factors for heart disease can be divided into modifiable and non modifiable. Modifiable risk factors include obesity, smoking, lack of physical

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activity and so on. The non modifiable risk factors for heart disease are like age, gender, and family history. Many people have at least one heart disease risk factor. Some kinds of heart disease are cardiovascular diseases, heart attack, coronary heart disease and Stroke. Stroke is a type of heart disease it is caused by narrowing, blocking, or hardening of the blood vessels that go to the brain or by high blood pressure [3, 4]. Taking care of clinical needs, such as making certain specific medical diagnoses, evaluating in a quick manner for avoidable health problem, or avoiding undesirable drug occasions, are the most standard exploitation of Expert System [5]. Expert System could also be possibly lessened costs, progression performance, and reduce client stress. These systems are classified into 2 groups namely (1) Knowledge based and (2) non-knowledge based [6]. The knowledge based system consists of rules (if-then statements). Expert system that is implemented with the assistance of artificial intelligence has the ability to support in a new setting and to learn for instance [7][8]. Given that the concept of computer-based Clinical Decision Support System aroused at first, significant research has actually been made in both academic and practical areas. Many obstacles are longer to impede the effective application of expert systems in scientific environments, among which portrayal and reasoning concerning clinical understanding predominantly under anxiety is the locations that require improved methodologies and strategies [9][10].

## II. VARIOUS CATEGORIES OF HEART DISEASE

In this section, the articles are reviewed based on different categories of heart disease such as coronary heart disease, coronary artery disease, heart failure, ischemic heart disease, cardiovascular disease, congenital heart disease, valvular heart disease and hypo-plastic left heart syndrome.

A. Coronary Heart Disease (CHD)
B. Coronary Artery Disease (CAD)
C. Heart Failure
D. Ischemic Heart Disease (IHD)
E. Cardiovascular Disease
F. Congenital Heart Diasease
G. Valvular Heart Disease
H. Hypoplastic Left Heart Syndrome

## III. SUMMARY OF LITERATURE REVIEWED

Even though various techniques have been used in the literature, still there is a need of good techniques to solve the following research issues.

- Identification of key attributes for better diagnosis of heart disease is very important task.
- The system must be able to handle Complexity of the large dataset for diagnosis.
- Data cleaning is a challenging task for heart disease database as some of the attributes values cannot be obtained usually.
- Selection of most suitable sample of data for classification instead of the whole data is another risk for getting better diagnosis.
- Weighting the attributes is difficult task but it shows the significant research direction to obtain best diagnosis report.
- Improvement on effectiveness is important research direction because the heart disease database is very sensitive.
- Handling of multiple class labels for prediction can be another positive direction of research since it can affect the performance of the medical diagnosis significantly.

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## IV. PROPOSED FUZZY SYSTEM

The Flow diagram of proposed fuzzy based system for heart disease is shown in figure 1. The various attributes/parameters and their values are chosen.

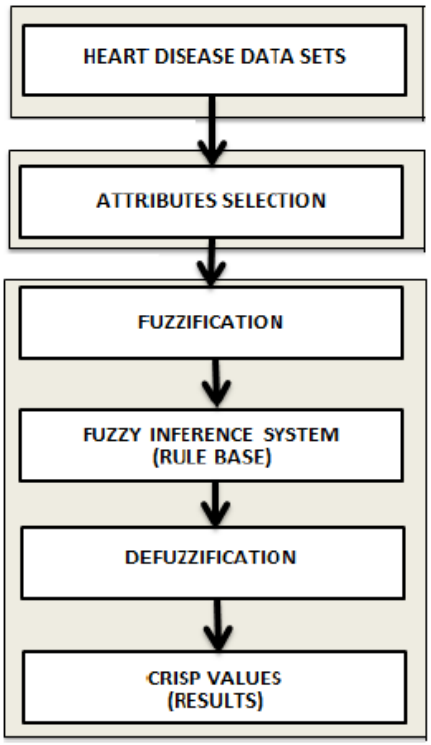


**Fig. 1: Flow diagram of Heart Disease Diagnose System**

(a) **Chest pain:** The values of attribute chest pain are shown in table1. The corresponding membership function diagram is shown in figure 2.

TABLE I. **CLASSIFICATION OF CHEST PAIN**

| Input Field | Range | Fuzzy Set |
|---|---|---|
| Chest Pain | 0-0.22<br>0-0.5<br>0.25-0.74<br>0.5-1<br>>1 | Very low<br>Low<br>Moderate<br>High<br>Very high |

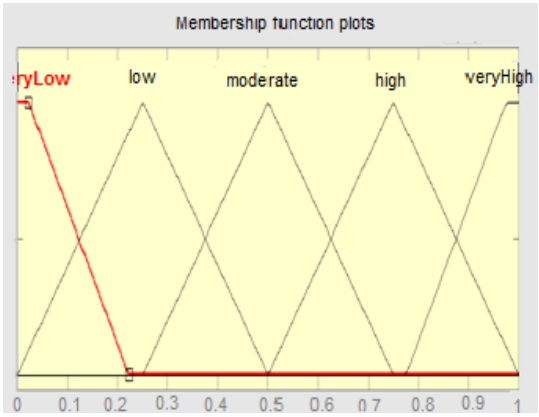


**Figure 2: Membership Function of Chest pain**

(b) **Blood Pressure**: We choose five different membership functions for input attribute Blood Pressure and are named as very low, low, medium, high and very high. This can also be shown in table II and its membership function is shown in figure 3.

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TABLE II. **CLASSIFICATION OF BLOOD PRESSURE**

| Input Field | Range | Fuzzy Set |
|---|---|---|
| Blood Pressure | <90<br>0-130<br>95-165<br>130-200<br>>170 | Very low<br>Low<br>Medium<br>High<br>Very high |

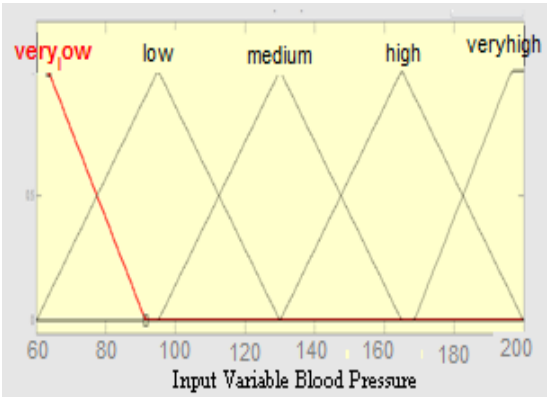


**Figure 3: Membership Function of Blood Pressure**

(c) **Cholesterol:** Cholesterol has salient affect on the result and can change it easily. We choose five different membership functions for input attribute cholesterol. The range and membership function of this attribute is shown in table III and figure 4.

TABLE III. **CLASSIFICATION OF CHOLESTEROL**

| Input Field | Range | Fuzzy Set |
|---|---|---|
| Cholesterol | <160<br>0-250<br>175-325<br>250-400<br>>375 | Very low<br>Low<br>Medium<br>High<br>Very high |

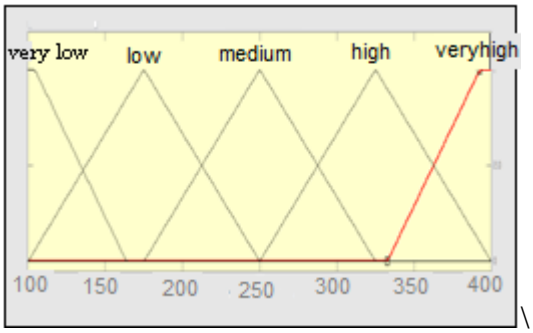


**Figure 4: Membership Function of Cholesterol**

(d)**Blood Sugar**: Blood sugar field is one of the most important factor in the diagnose of heart disease. The input attribute Blood Sugar, five different membership functions are used which is given as very low, low, medium, high and very high . The range and the membership function of this attribute are given in table IV and figure 5.

TABLE IV. **CLASSIFICATION OF BLOOD SUGAR**

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| Input Field | Range | Fuzzy Set |
|---|---|---|
| Heart Rate | <88<br>70-110<br>90-130<br>110-150<br>>132 | Very low<br>low<br>Medium<br>High<br>Very high |

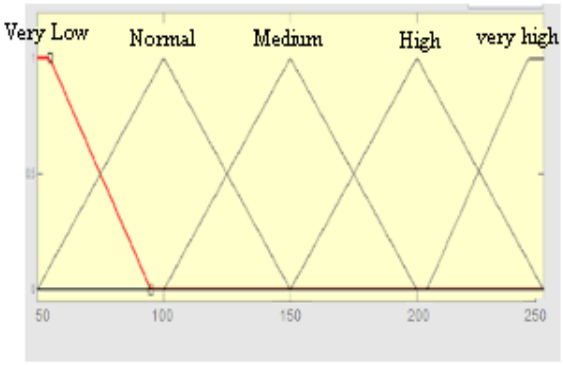


**Figure 5: Membership Function of Blood Sugar**

### (e) Heart Rate:

Heart Rate has five different membership functions i.e. very low, low, medium, high and very high. The range and membership function of this attribute is given in table V and figure 6.

TABLE V. **CLASSIFICATION OF HEART RATE**

| Input Field | Range | Fuzzy Set |
|---|---|---|
| Blood Sugar | <90<br>50-150<br>100-200<br>150-250<br>>205 | Very low<br>Low<br>Medium<br>High<br>Very high |

Membership Function of Heart Rate

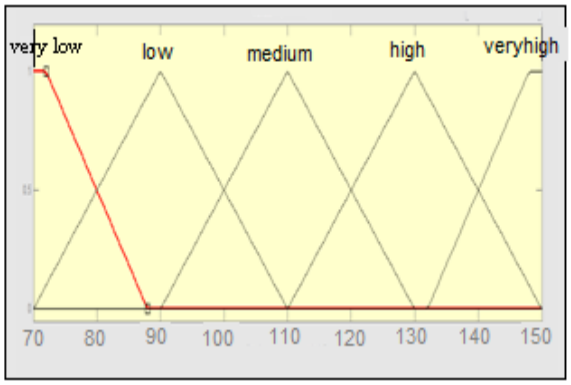


**Figure 6: Membership Function of Heart Rate**

### (f) Old Peak:

This input attribute means ST depression induced by exercise relative to rest. Old peak field has 5 fuzzy sets (Very Low, Low, Medium, Terrible and risk). These fuzzy sets have been shown in table VI with their ranges and their membership function in figure 7.

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TABLE VI. **CLASSIFICATION OF OLD PEAK**

| Input Field | Range | Fuzzy Set |
|---|---|---|
| Old peak | <0.2<br>0-0.5<br>0.25-0.75<br>0.5-1<br>>0.7 | Very low<br>low<br>Medium<br>Terrible<br>Risk |

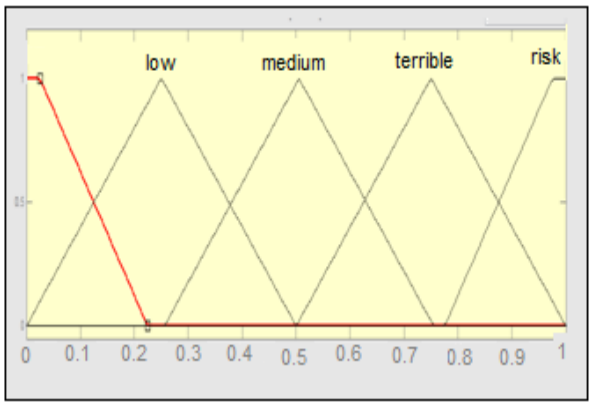


**Figure 7: Membership Function of Old Peak**

## V. RESULTS

The system recognizes the presence or absence of heart disease and also gives the precaution necessary to avoid the disease.

The "goal" field refers to the presence of heart disease in the patient. It is integer value from 0 (no presence) to 1. By increasing of this value, heart disease risk increases in patient. In this system, we have considered a different output variable, which divides to 5 fuzzy sets Healthy, Low Risk, Moderate Risk, Risk, and High Risk. Figure 8 shows these fuzzy sets with their ranges. The system performance is verified with the actual data of patient and it is found that the proposed system gives optimal results. The accuracy of the proposed fuzzy based system is quite well.

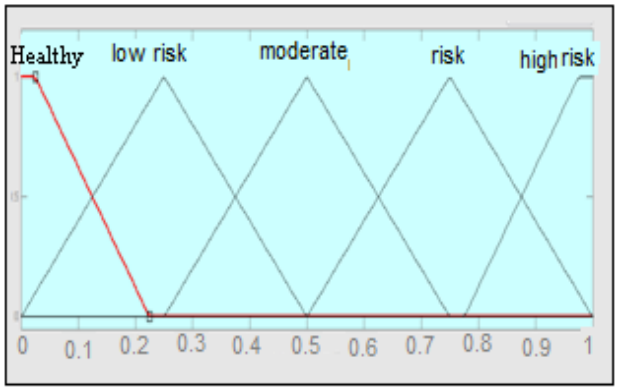


**Figure 8: Membership Function of Result**

## VI. CONCLUSIONS

In this paper the existing prediction system for heart disease are studied. Each technique is unique in its own way, which might be suitable for different applications. Heart disease is a fatal disease by its nature and misdiagnosis of this disease can cause serious, even life threatening complications such as cardiac arrest and death. We proposed a fuzzy based heart disease diagnose system. The performance of the system is evaluated and it provides more than 90% accuracy.

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